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ABSTRACT

The SENNAPE (Software Engineering and Neural Networks Applied to Physics and Electricity) project has been putting together the European and the Brazilian industries towards neural processing developments in the fields of high-energy physics and electricity. It is a multi-disciplinary international collaboration with the participation of different institutions and industries. The project is a platform of technology transfer, using the World Wide Web as the main information repository. Among team members of the various phases of the project, undergraduate and graduate engineering students are experiencing the development of a complex project and the importance of integrating their knowledge of basic sciences into engineering design. (Author)

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The SENNAPE Project: An University-Industry Joint Program in Information Technology

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Abstract *The SENNAPE (Software Engineering and Neural Networks Applied to Physics and Electricity) project has been putting together the European and the Brazilian industries towards neural processing developments in the fields of high-energy physics and electricity. It is a multi-disciplinary international collaboration with the participation of different institutions and industries. The project is a platform of technology transfer, using the World-Wide Web as the main information repository. Among team members of the various phases of the project, undergraduate and graduate engineering students are experiencing the development of a complex project and the importance of integrating their knowledge of basic sciences into engineering designs.*

Introduction

The Federal University of Rio de Janeiro (UFRJ) has been developing applications of neural processing in a number of different fields. In particular, in high-energy experimental physics, the ability of artificial neural networks in performing efficient feature extraction has been successfully used in pattern recognition problems that exhibit input data spaces with high dimensionality [1]. Not only artificial neural networks are generally beating classical methods in the offline analysis, but also its fast response feature can be considered very attractive for online operation [2]. Most of the activities of UFRJ in this field of physics were developed in the framework of international collaborations which were based at CERN (European Center for Nuclear Research).

UFRJ has also been active in the field of electricity, where artificial neural networks are receiving an increasing attention from researchers [3]. From a number of successful projects, strong links between UFRJ and the Brazilian company of electrical power transmission (Eletrobras) could be established.

The experience accumulated in the physics and electricity domains supported the proposal of the SENNAPE (Software Engineering and Neural Networks Applied to Physics and Electricity) project. Putting together the European and the Brazilian industries towards neural processing developments in the fields of high-energy physics and electricity, the SENNAPE project was approved in 1995 to be financially supported by the European Commission. Under the scientific coordination of UFRJ, the partners - Telmat Multinode, from France, CERN, and CEPEL (Eletrobras), from Brazil - are applying modern engineering techniques for building a fast decision system for collider experiments, and an electrical load monitoring system for household appliances. The project also involves FUJB, one of the UFRJ's foundations, for handling most of the administrative and financial issues.

The SENNAPE is being developed in a collaborative framework. Professors, researchers, engineers, physicists, undergraduate and graduate students have been working together in a multidisciplinary environment that combines modern engineering techniques and basic science knowledge. In spite of the variety of experiences and the different concerns of team members, the collaborative effort in SENNAPE has been producing significant scientific and industrial contributions. Intensive use of the World Wide Web (WWW) has been of considerable importance to make the project coordination feasible and efficient.

In the next section, the development platform of the SENNAPE project is briefly described and the main features of both applications are highlighted. The third section addresses project management and administration, and the last derives some conclusions.

Neural Classifiers and Implementation Issues

In the framework of the SENNAPE project, the implementation of neural networks is carried out in a parallel processing environment. Both target applications in physics and electricity require massive data processing and speed. For this, the baseline of the project consists in distributing data to nodes which perform the required neural processing. Therefore, both efficient communication between nodes (to receive input data and communicate their corresponding outputs)

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and fast signal processing capabilities are among project achievements.

The Development Platform

The TN-310 system was selected as the development platform of the SENNAPE project. This is a multiple instructions multiple data parallel computer with a distributed memory architecture [4]. The main components are processors and the C104 based switching network that allows each one of the available 16 nodes to access data held anywhere in the system. Processing nodes include T9000 transputers (mainly used for communication purposes) and DSPs (ADSP-21020 devices, for optimizing the signal processing applications). Each processing node has access to the communication network through four high speed (100 Mbits/s) serial links.

Triggering System for Physics

In the field of experimental high-energy physics, the fundamental structure of matter is mainly studied by colliding packets of high-energy particles and analyzing the reaction products by means of a set of detectors with electronic readout.

At CERN, a new collider machine (LHC - Large Hadron Collider) is being developed to enter into operation by 2005. The LHC will be colliding bunches of protons at each 25 nanoseconds, so that an enormous amount of data will be produced in the longtime run. However, the great majority of the generated events shall be discarded, as they will constitute the background noise of the experiment. The experiment will focus on very rare events that shall be identified by an online triggering system which is under development.

In SENNAPE, the triggering system is designed by using neural networks. The operation of the system is split into two phases [5]. In the first, relevant information readout from four different detectors are analysed by feature extraction processors, in order to translate raw detector data into intelligent variables. Neural feature extraction is performed for calorimeters, which are important multi-cell detectors used to measure the energy of the incoming particles. For the other three detectors, classical methods [5] were simulated. The next phase performs neural particle identification by using global decision units (gdu) that combine the extracted features.

Due to communication overheads, only 13 nodes proved to be enough for an optimal implementation, as additional processing nodes in the chain would become idle. Complete data processing was achieved in 380 μs, which is acceptable for the data volume and complexity involved. Improvements on this performance are being pursued by fully exploring the speed of the DSPs as neural processors [6].

Electrical Load Monitoring System

The knowledge of the domestic electrical power consumption profile is of considerable importance in Brazil, as this kind of application responds for about one quarter of the total demand. Thus, information on the characteristics of this segment is valuable for energy conservation, demand-side management purposes and investment evaluation on the quality control and efficiency of appliances. Domestic load monitoring can also play a role in alleviating the electrical system in peaking periods, avoiding interruptions and delaying the needs of huge investments.

Addressing such needs, a neural nonintrusive load monitoring system was developed for household appliances and was implemented in the TN-310 system. Nonintrusive methods are considered the most effective way to have access to such consumption profile. On the other hand, if a massive data processing is needed, the speedup in processing time that can be obtained by means of the parallel machine becomes valuable.

For developing such system, transient and steady-state responses of the appliances were acquired from the AC power line [7]. The transient response was sampled by a digital storage oscilloscope and the steady-state response was measured from a power transducer and a digital voltmeter. For compactness, data were preprocessed by a combination of variance and spectrum analysis.

The implementation of a prototype of such system used two master processors acting as data distributors, whilst the other 14 processors were allocated for data preprocessing and neural processing. The processing time was smaller than 20 μs. In order to improve performance, principal component analysis [8] is being applied to both raw and preprocessed data, in such a way that more compact neural networks and faster preprocessing methods can be achieved. This is under development.

Software Engineering Support

The neural processing applications developed for a parallel machine are very complex due to the fact that they require high speed performance and manipulate huge amount of data through communication among processes. It is very important that such sophisticated systems achieve as much reliability as possible. In

order to support the system development, software engineering techniques concerning mainly modeling, simulation, testing and documentation were applied.

Each participating student was responsible for the development of one part of each system. Then, all applications were integrated and validated. The system modules were developed incrementally. Within this approach, a program is delivered to run in early stages of the development phase, even if it is not complete. Then, new functionalities were subsequently implemented to deliver the next version until the application is complete.

Software testing is the process of exercising a product to verify whether it satisfies specified requirements and to identify differences between expected and actual results. The purpose of testing is to discover faults during the test phase and thereby prevent failures in the operational phase. Systematic software tests were applied to detect inconsistencies, offering additional insight into the completeness and correctness of the applications.

In order to support distributed software development, the World-Wide Web was used due to the fact that it merges the techniques of networked information and hypertext to make an easy but powerful global information system. Moreover, the Web provides hypermedia functionality for structuring and accessing information, which can be used to rapidly advance the state of the art in computation and change the way software is developed, maintained, tested, and optimized. The great interconnection among machines fostered by the Internet has allowed programs to be distributed easily and used widely.

Within the Web, a framework was implemented as hypertext forms to acquire the software information during its construction process. The software information is then organized as hierarchical hypertext nodes. These templates allow developers describing generic information of the application that is being constructed. Outside documentation technical reports, manuals and papers can be easily inserted. The hypertext templates also support the description of the system components and the recording of decisions taken, foreseeable modifications, and constraints. They facilitate the design, organization, and presentation of a collection of knowledge in the form of hypertext. The usage of a template definitely speeds up the production of documents.

Management and Financial Administration Issues

The SENNAPE project is an international cooperative effort of more than 30 researchers and students from different departments of UFRJ and different research centers and companies. To achieve the project goals in such diverse framework, project management and administration were important issues. With this respect, two main lines of actuation of the project coordination can be highlighted:

- The continuous search of the means to keep in track the efforts of the different institutes and companies, so that project development could proceed as smooth as possible and proposed deliverables and project goals could be achieved.

- Special attention to financial and administrative issues, which demanded a considerable effort of the collaboration in order to surmount difficulties.

Technology Transfer

The overall objective of the SENNAPE project was fostering an European and Brazilian information technology collaboration with technology transfer between research and industry both in Europe and Brazil.

The development of the electrical load monitoring system represented the most important industrial link of SENNAPE. The project was very successful in strengthening such university-industry link, as the achieved results of the project are being used to produce an industrial prototype of the monitoring system, envisaging a commercial use in the near future. Although good scientific results proved the capability of the chosen technology (transputers and DSPs in a parallel processing environment) for achieving the project goals, the tendency of using more general-purpose processor technologies for local processing is being established, as this would result in a more cost-effective solution. Present activities follow such direction and include the enlargement of data samples (from appliances that were recently introduced in the market) and prototype development both in stand alone DSPs and standard processors.

Technology transfer encompasses not only the introduction of a new technology into a sector, but also the diffusion of best existing practices within the sector. The SENNAPE project is the platform of a technology transfer in information technology, where students have an important role as they learn, apply and continue working with modern technologies. When a technology is acquired what is actually transferred is the information in codified form (documents, design sheets, software, etc.). The ability to make use of this information and the managerial know-how available is that makes a profitable acquisition.

In the field of engineering, the technology evolves quite substantially in a time-base of few years. Projects that involve technology transfers and university-industry relationship are of considerable importance to keep the university updated with respect to the frontiers of the technology and capable to realize what is feasible to be achieved in practical applications. Moreover, a cooperative and multi-disciplinary framework can be of inestimable help in the integration of the various subjects presented in regular courses, for which students usually can not establish connecting bridges in practical applications.

From these considerations, the SENNAPE project is being evaluated of great importance in terms of preparing the students for the next century and advancing the research activity at UFRJ. Team members have been experiencing new methodologies and techniques, such as software engineering, digital signal processing, and parallel computing. Profiting from such experience, the human resources employed in SENNAPE have an excellent opportunity to upgrade their technical knowledge and increase their managerial capabilities. In particular, the group of students involved in the project can fastly evolve and be better prepared to become future engineers or researchers, as they can deeply test state-of-art devices and systems in such advanced applications.

The work developed in physics can be considered as a seed for industrial growth, as several techniques that were developed at CERN found application in a variety of fields. As an example, detector and related signal processing developments are being applied in the medical domain along this decade. In the case of SENNAPE, the developments and implementations of neural networks and preprocessing methods can be widely applied. Some applications in the speech processing domain are already in progress.

The Role of Students

The involvement of graduate and undergraduate engineering students since the beginning of the project has been important for developing and complementing their knowledge on advanced fields like parallel processing, digital signal processing, neural computation, data acquisition and software engineering. The participation of students in the richful framework of SENNAPE allows them to experience the development of a complex project and to evaluate which are the important tools that motivate diverse people to evolve towards a common goal.

The SENNAPE project, as a multi-disciplinary project, also helps students to understand how important is to integrate their knowledge of basic sciences into engineering designs. This is very important to their education and preparation to a sophisticate market that, as it was already mentioned, evolves quite rapidly.

The intensive use of Internet and the integration of information by means of the Web are also being valuable gains to the students involved in SENNAPE. The current use of such tools is in very good agreement with recent educational efforts carried on at UFRJ that search for making use of the Internet facilities in local and distance learning activities and for general teaching support. This new age for undergraduate and graduate engineering courses is being well experienced by the students due to the collaborative way the SENNAPE project is being developed.

The dissemination of the project in local and international workshops and conferences has been performing with the enthusiastic participation of students, who have been profiting from the development of their abilities for presentations and from contacts with specialized audiences.

Coordination of the Cooperative Tasks

In order to coordinate the project activities and face difficulties, the realization of local and general meetings and the intensive use of World Wide Web dissemination are playing an important role to project success.

The project development has been accomplishing through the cooperative efforts of team members who have to maintain an active information base in order to improve communication and coordination. The use of Internet is shortening the distance amongst researchers from UFRJ and CERN, and is helping in solving most of the administrative difficulties. Electronic mail and newsgroup features are integrated into the Web to provide a natural mechanism for group discussions. In particular, the communication tools support the creation, organization and viewing of the activities. They display the information ordered either chronologically or by segment developer.

Local meetings that involved the project coordination, researchers and students have been organized to identify the difficulties and the best way to proceed. Tracking such difficulties in time was of considerable help for speeding up the project development, as it was required as a consequence of the long delay in machine delivering (see next). Specific meetings with the industrial segments in SENNAPE were also valuable to establish the applications and to get feedbacks from the potential users. Due to travel expense restrictions in the project budget, general

meetings have been organized around important project milestones, so that project achievements could be consolidated.

Financial Administration

The participation of FUJB with its autonomous administrative and financial structure was mandatory in facing problems. However, it took some time to the European Commission to realize the role of a university's foundation in such project. Due to the need of a contract amendment, in order to introduce FUJB as a partner, the final signature of the contract was delayed by six months. This displacement of project schedule had a negative impact in the budget allocated to the project.

The main difficulty faced by the project in the early stages was the significant delay in the delivery of the parallel machine. The machine was supposed to be purchased in stallments, as according to rules established by the European Commission. However, this would represent a significant increase in project costs, as the Brazilian Central bank required unaffordable financial warranties for such operation. As a result of this operational mismatching, the machine was installed at UFRJ with a delay of more than one year. This fact reduced considerably the time available for project development.

Communication gaps between project coordination and Commission officers caused additional delays and loads to the administration of the project. This was considerably reduced when the European Commission decided to change the officer in charge of the project due to inefficiency.

From this experience, it was learnt that the university's foundation should have been involved since the very beginning of the project. The administration of a such international collaborative project requires not only a considerable managerial efficiency but also a deep and detailed knowledge of money transfer requirements and the impact on project disbursements provoked by additional costs (not usually well estimated) such as customs (freight, warehouse, forwarding agent, etc), currency exchange and bank's taxs and duties. It is also crucial to find the best way to accommodate financial national rules and vendor needs. However, it can also be said that this experience is twofold, as the European Commission is now much more aware of these difficulties that may surge when non-European countries get involved into a project.

Deliverables and Future Developments

The two main deliverables of the project, as described before in the second section of this paper, are being finalized. Taking advantage of the presence of the parallel machine at UFRJ, a digital filtering application was also developed, although this activity was beyond the original proposal. Dissemination of main results are being carried out through papers presented at local and international conferences, presentation of master and PhD theses, short courses, and interviews to local newspapers. The parallel machine will be kept installed at UFRJ after the closing date of the project and it can be of use on further advances of ongoing project topics and on new developments.

The full exploitation by UFRJ's researchers of the high performance computing machine (TN-310 system) is being highly stimulated by the project coordination. As a consequence of machine availability and project development, other parallel computation Brazilian groups already active within and outside UFRJ were contacted. In this sense the project is playing an important role to help different research groups to communicate and share experiences.

In order to continue using the TN-310 system after project completion, the project coordination is putting a considerable effort to attract and propose future applications and further developments of some topics of the original proposal. The experience of SENNAPE collaboration in terms of technology and University-industry relations is also backing the present efforts in building South-American collaborations (mainly in electrical power transmission systems) in the framework of the Mercosul economical agreement.

Conclusions

The SENNAPE project aimed at fostering an information technology transfer between research and industry both in European and Brazil. From the technical level, the SENNAPE project aimed at applying software engineering and neural network techniques to complex problems in the field of physics and electrical power distribution systems. The goals were successfully achieved with the active participation of graduate and undergraduate students within an international collaboration project. These students, that are now becoming engineers, will bring their experience and know-how either to our industry or to future research projects.

Two very important issues in a such collaborating project with international industry-university/research center relationships are management and administration.

Management includes human and equipment resources steered to achieve the project objectives and to accommodate different points of view and interests of the collaborators. To achieve these goals in SENNAPE, some meetings were organized to exchange ideas and discuss the evolution of the project through the computer network and publishing information on the Web. For project administration, importing equipment and dealing with constraints imposed by national authorities, FUJB was in charge and these tasks represented quite a considerable effort.

Given the opportunity of the presence of the TN-310 system at UFRJ, other interesting applications are going to be developed, although this is beyond the scope of the approved proposal. Thus, the project succeeded in enlarging the original range of parallel applications for disseminating the use and profiting as much as possible of this high performance parallel machine.

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References

[1] Seixas, J.M., Calôba, L.P., Souza, M.N., Braga, A.L., Rodrigues, A.P., "Neural Second-Level Trigger System Based on Calorimetry", *Computer Physics Communications*, 1996, Vol. 95, pp 143-157.

[2] Bock, R.K., Carter, J., Legrand, I.C., "What Can Artificial Neural Networks Do For the Global Second Level Trigger", 1994, CERN-ATLAS/DAQ-11.

[3] "Lecture Notes on a Course on Intelligent Systems Applied to Power Systems", Cepel, November 1997, Rio de Janeiro, Brazil.

[4] Telmat Multinode, "TN-310 System Manual and Training Set", 1995, France.

[5] The Atlas Collaboration, "Technical Proposal for a General-Purpose pp Experiment at the Large Hadron Collider at CERN", 1994, CERN/LHCC/94-43.

[6] Seixas, J.M., Calôba, L.P., Anjos, A.R., Dantas, A.C.H., Linhares, R., "Fast Neural Decision System Based on DSPs and Parallel Processing", *International Conference on Signal Processing Applications & Technology*, 1997, pp 1629-1633, San Diego, USA.

[7] Seixas, J.M., Calôba, L.P., Aguiar, J.C.R., Prado, C.B., "A Neural Nonintrusive Electrical Load Identification Using a Parallel Machine", *International Conference on Engineering Applications of Neural Networks*, 1997, pp 277-280, Stockholm, Sweden.

[8] Seixas, J.M., Calôba, L.P., Prado, C.B., Aguiar, J.C.R., "Neural Discriminating Analysis for a Nonintrusive Electrical Load Monitoring System, *IX SBAC-PAD Symposium*, 1997, pp 201-210, Campos do Jordão, São Paulo, Brazil.

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